CP, B's and CKM Matrix Elements

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PDG Advisory Committee Meeting

LBNL, November 14, 2004

- What's new in RPP 2004
- Issues in B's
- Issues in CKM Elements
- Issues in CP
- Prospects for 2006 Edition

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What's New

- B physics continues to be one of the most productive fields in RPP.
- There were 116 papers and 459 measurements encoded since RPP2002.
- Highlights:
  - $sin2\beta = 0.726 \pm 0.037$ (PDG2002: 0.79 ± 0.14)
  - Observation of direct CP violation in charmless B decays (not in RPP 2004 yet)
  - Many rare decays have been observed
  - Further Improvements of B lifetimes, Mixing and V_{cb} and V_{ub} CKM elements
  - Evidence for new physics ?
  - Excellent updated minireviews

First Observation of Direct CPV in B Decays

$B^0 \to K^+\pi^-$

BABAR *hep-ex/0408057, submitted to PRL*

$A_{CP} = -0.133 \pm 0.030 \pm 0.009$

4.2σ

Belle **Confirmation at ICHEP04**

Signal ($274M$ $B\bar{B}$ pairs): 2140 ± 53

$A_{CP} = -0.101 \pm 0.025 \pm 0.005$

3.9σ

Average $A_{CP} = -0.114 \pm 0.020$

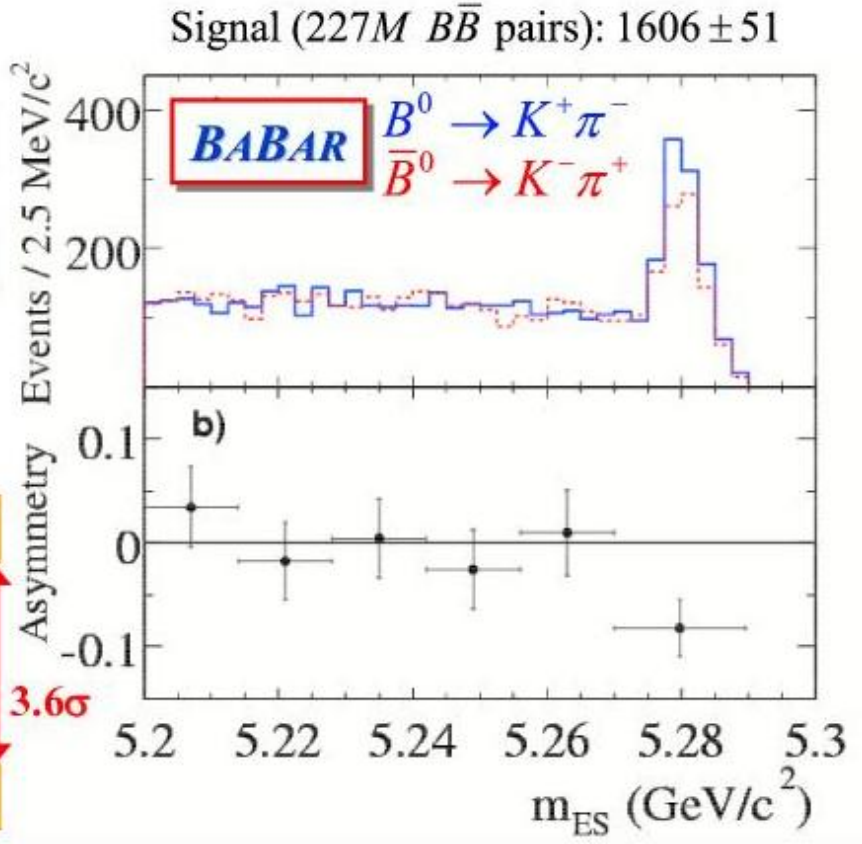
$B^+ \to K^+\pi^0$

$A_{CP} = +0.06 \pm 0.06 \pm 0.01$ *BABAR*

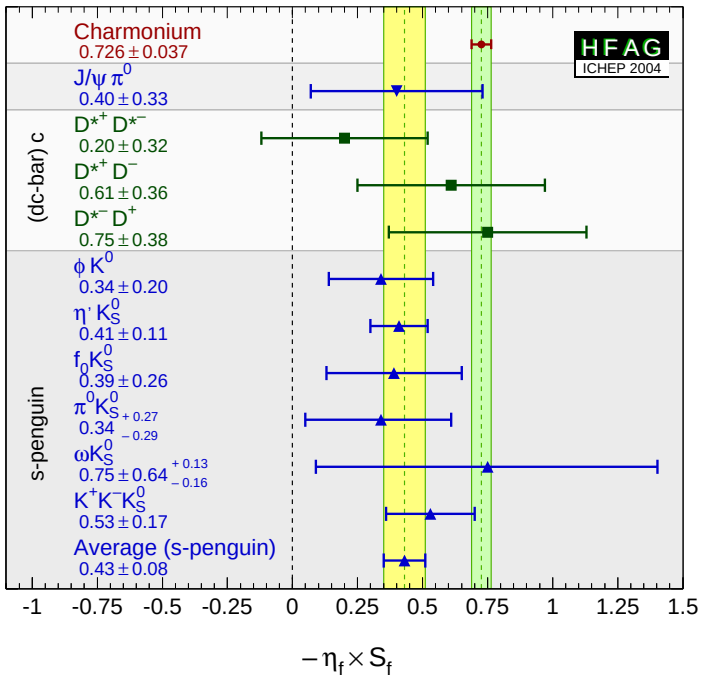
$A_{CP} = +0.04 \pm 0.05 \pm 0.02$ Belle

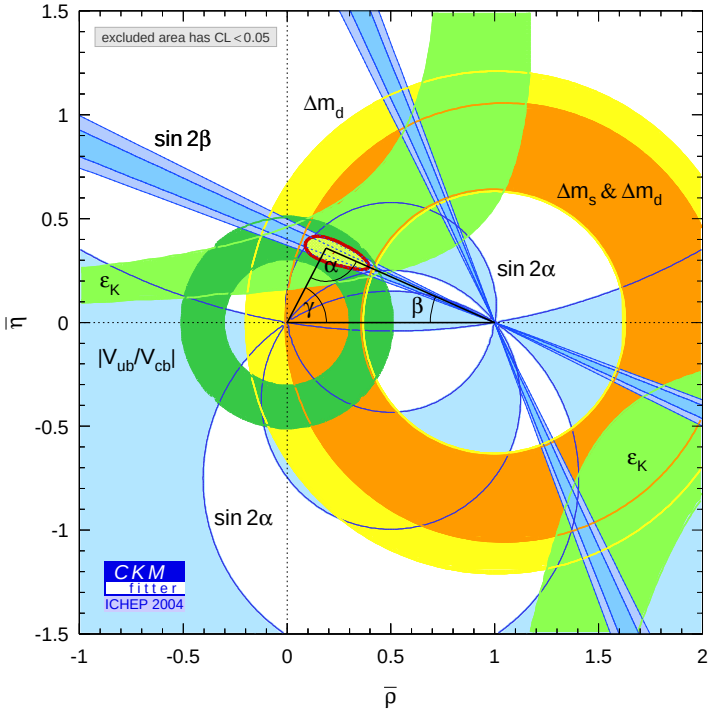
3.6σ

Average $A_{CP} = +0.049 \pm 0.040$



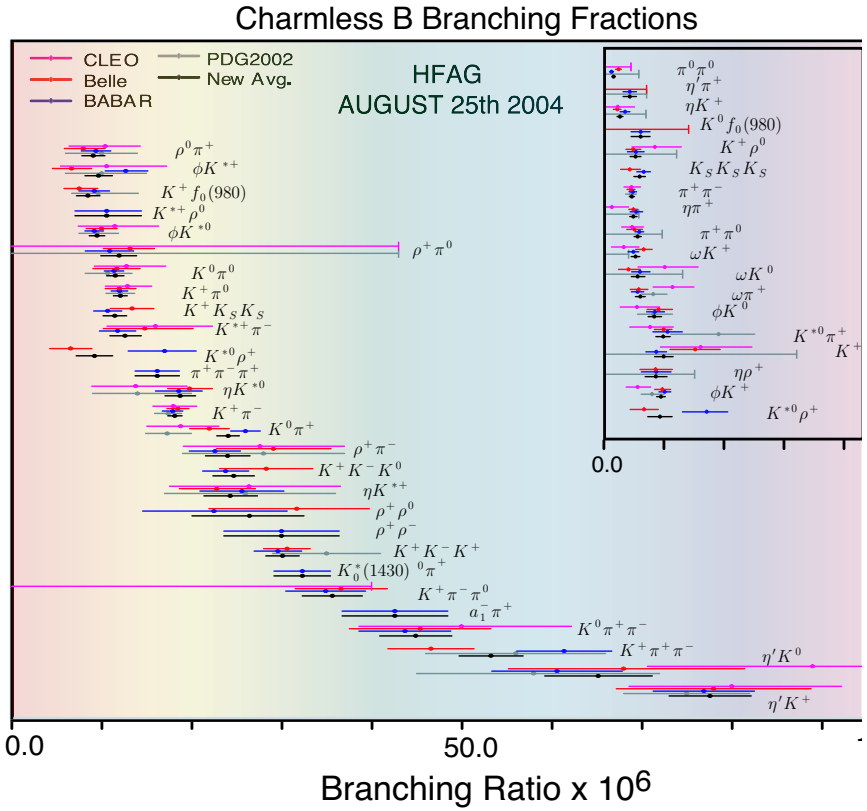
CP Parameters and CKM Fits

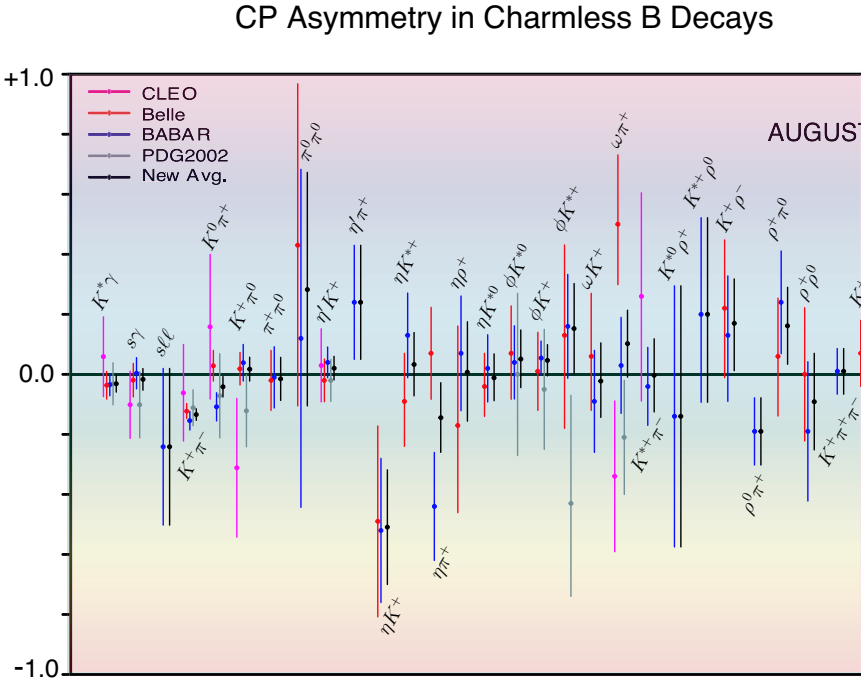




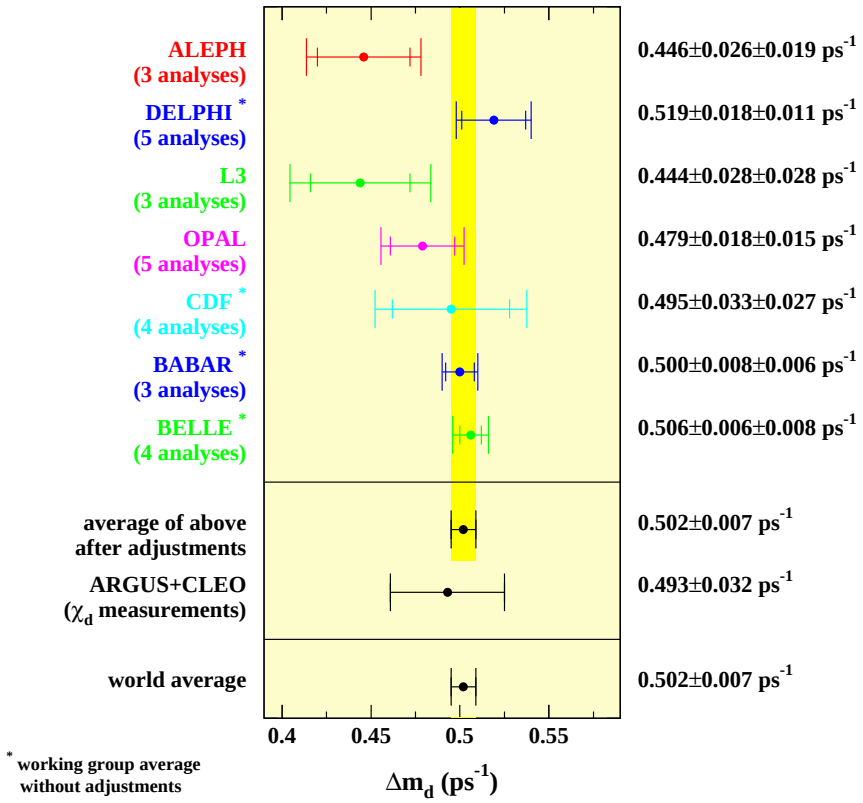
- $S_{J/\psi K_S} - S_{\eta' K_S} = 0.31 \pm 0.12$ (2.6σ) Largest single deviation from SM
- $S_{J/\psi K_S} - < S_{b->s} >= 0.30 \pm 0.08$ (3.5 σ)

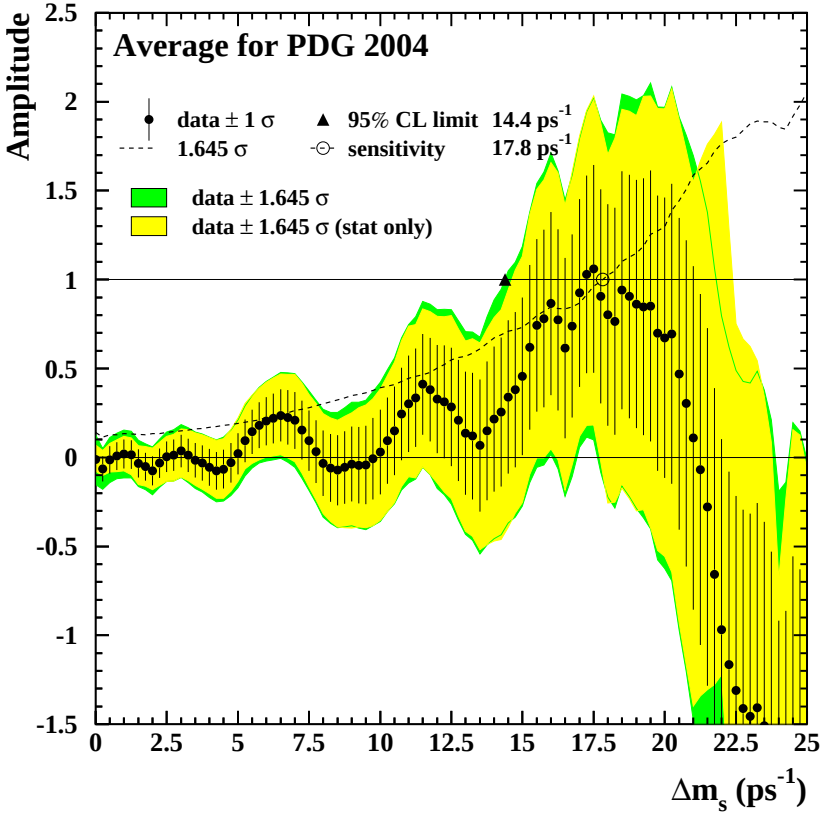
Rare Decays and CPV





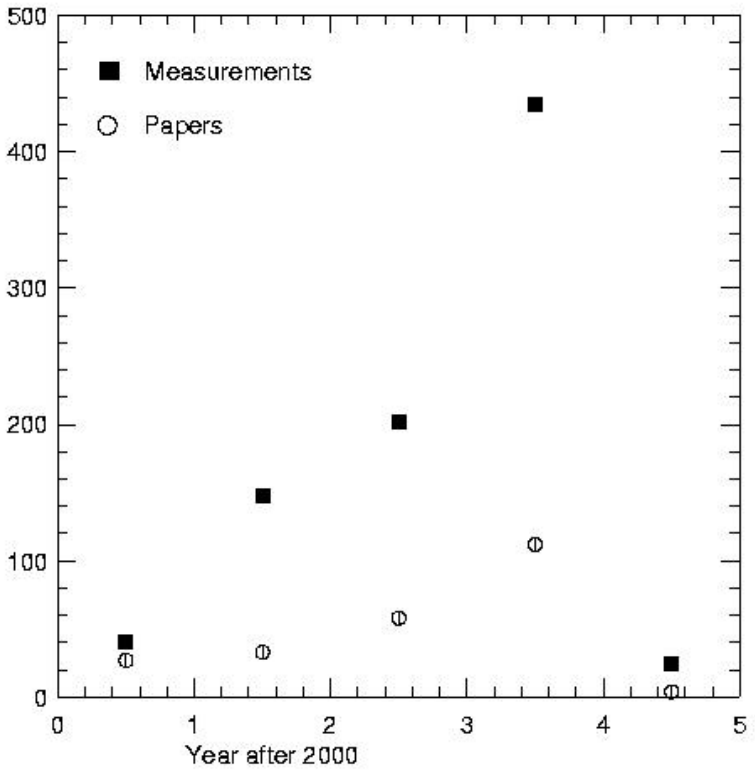
B_d and B_s Mixing



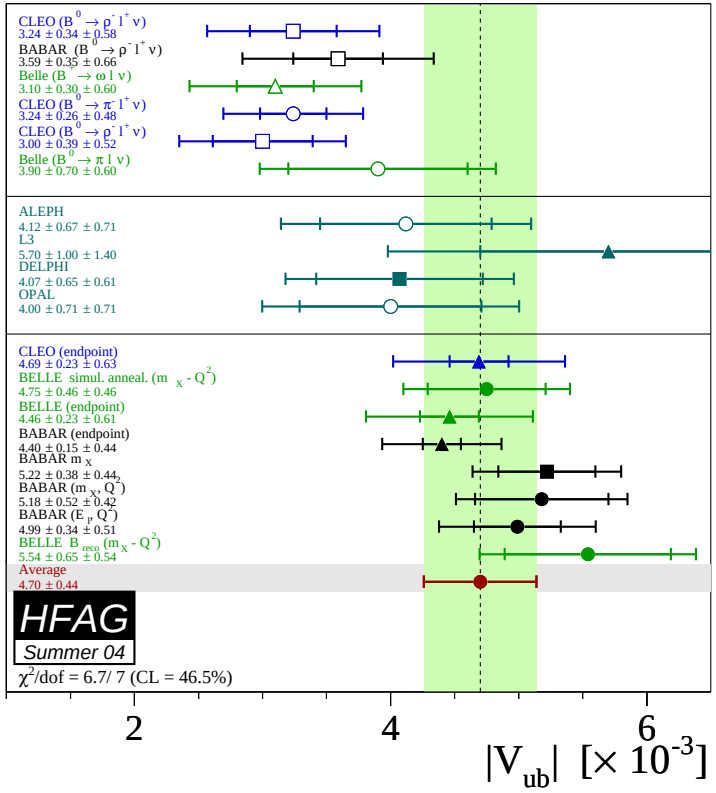


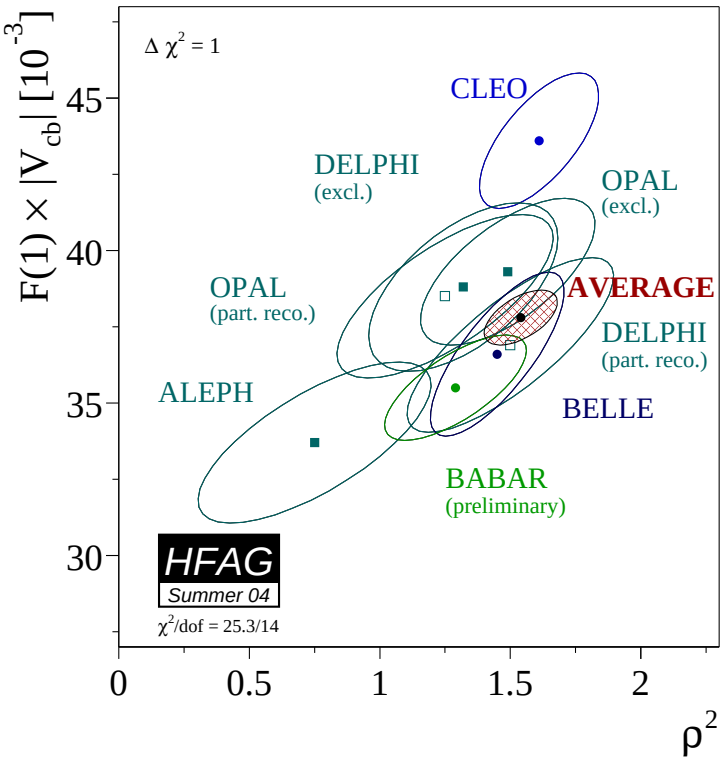
Issues in B Sections

- There are many papers from two B factories and more to come from Tevatron Run II.
- We are thinking of recruiting a third encoder from Tevatron experiments. So he/she can share some workload.
- Continue to work with Heavy Flavor Averaging Group (See David's talk)



Issues in V_{cb} and V_{ub} CKM elements





- Excellent minireviews focusing on the experiment aspects.
- Determination of V_{cb} – (M. Artuso and E. Barberio)
- Determination of V_{ub} – (M. Battaglia and L. Gibbons)

Concerns about V_{cb} and CKM Reviews

- Complaints from Bigi, Isidori, Pene, Roudeau plus Gambino and Stocchi about the V_{cb} minireview (Artuso and Barberio) and the CKM review (Gilman, Kleinknecht and Renk).
- General Concerns:
  - Some of these people (Bigi and Roudeau) were referees of the review and "provided lengthy and detailed critiques comments on time." They received no feedback and their criticisms were either "completely ignored" or led to "cosmetic" changes.
  - V_{cb} review had "misleading or even incorrect claims concerning theoretical issues." Relevant theoretical and experimental papers were " not listed among the references".
    (Some of critiques were just reflection of old debates between various camps. We also had referees like Neubert, Ligeti, Browder, Luth ..., who seem to like the review. These are difficult issues and we should do a better job next time, See the proposal later.)
- Specific Concerns about V_{cb} Minireview
  - $B \to l\nu D^*$: The referencing of $F_{D^*}(1)$ is "very sloppy", should delete the quark model estimates by Falk & Neubert (1993) and lattice QCD calculation and keep only the work by Shifman et al. The final $F_{D^*}(1) = 0.91 \pm 0.04$ is taken from the CKM workshop (2002). (The authors did provide a fair overviews of the relevant literature without taking sides)
  - $B \to l\nu X_c$: 'HQET' and 'Wilsonian approach" are treated as completely equivalent, which is demonstrably wrong. (Again, the authors were instructed to present both views without getting into the arguments.)

- The Moment analysis of DELPHI paper was treated unfairly in a single sentence " Moments of the M_x distribution without an explicit lepton momentum cut have been extracted from preliminary DELPHI data [58] and give consistent results". (The result was in conference form for many years and was not published by the time of deadline for RPP 2004.)
- The discussion of the complex subject of " quark-hadron duality" is particularly "hard to swallow". Where does their 6% number come from for non-quantified assumptions in the inclusive measurements ? (The authors tried to set a limit by comparing the V_{cb} differences between inclusive and exclusive measurements. But I agree it can be improved in the future with new results from B factories and some help from our theory friends).

Specific Concerns for CKM Review

- The authors use the V_{cb} minireview as input. (They were instructed to do so)
- Their statement that in analysis " of inclusive decays, where the measured semileptonic b hadron decay width is assumed to be that of a b quark through ...the V-A interaction, depends on ... the validity of quark-hadron duality" is an untenable simplification that ignores a decade of careful studies. They also just state an ad-hoc uncertainties of 1% in V_{cb} inclusive measurement due to duality violation, without explaining or referencing to other finding in the literature. At the same time they accept the stated uncertainty on V_{cb} in exclusive as gospel. (These are long-standing arguments between two camps (exclusive vs inclusive) and both have issues that need to be verified with the experimental data from B factories.)
- Their discussion of V_{us} has become quite obsolete due to the very recent KTEV results that came out after it was written. The problem of how to properly treat soft photon correction has been an issue when averaging the old and new data. The review also ignores the inconsistency of the K_{l3} form factor slopes, as extracted from electron and muon modes. (these are important issues, which should be addressed in the next edition)
- Bigi's Suggestion
  - Choice of subjects: other CKM elements may deserve their own minireviews, such as V_{us}, V_{cs} and V_{cd}. (That's a possibility, but CKM review should be the right place to discuss all these)

A Proposal for new V_{cb} and V_{ub} Minireview

- There has been lots of progress made in the V_{cb} and V_{ub} area since the last PDG workshop held at LBNL in 2000.
- It seems a good time to rethink again what we want for PDG 2006 edition
- The next CKM workshop 2005 will be held at UCSD next March. The intended working groups are 1) Determination of V_{ud} and V_{us}; 2)Determination of V_{cb} and V_{ub}; 3) V_{td}/V_{ts} through mixings and rare B and K decays; 4) Angles from charmless B decays; 5) Angles from B decays with charm; 6) CKM fits and New Physics.
- One idea is to combine V_{cb} and V_{ub} together along with the theory part, written jointly by one or two experimentalist (B factories) and a theorist.
- Of course, there are some concerns about this approach, but your comments on the scope and authorship are extremely welcome.

Issues for CP Violation

- Following the PDG advisory committee's recommendation, we have successfully combined several CP violation related reviews into a single coherent CP review, which covers all meson decays (K, D, and B).

- CP Results:

  – CP Violation in Meson Decay – D. Kirkby and Y. Nir
  – Some of CPV searches are also discussed in "Production and Decay of b-flavor Hadrons" by Y. Kwon

- There are lots of exciting results recently reported from B factories, such as direct CP violation and possible discrepancy of CP parameters between charmonium and s-penguin.

- Should we feature a separate, but short minireview summarizing the results with tables and figures ?

Prospects for 2006 Edition

- Continue to work with Heavy Flavor Averaging Group providing the world best B decay parameters

- Planning for a new set of minireviews
  - V_{cb} and V_{ub} CKM Elements
  - Production and Decay of b-flavor Hadrons
  - A Separate, short minireview on CPV in B decay ?
  - B and B_s Mixing
  - ...

- Hope new physics from B decay will emerge soon. This is an exciting time and PDG will be ready for the challenges.